

Arsenic Removal Technology for Public Water Supplies

Mike Howell

Drinking Water Quality Team
Public Drinking Water Section
Texas Commission on Environmental Quality

Presented at:
TCEQ Environmental Trade Fair
May 2005

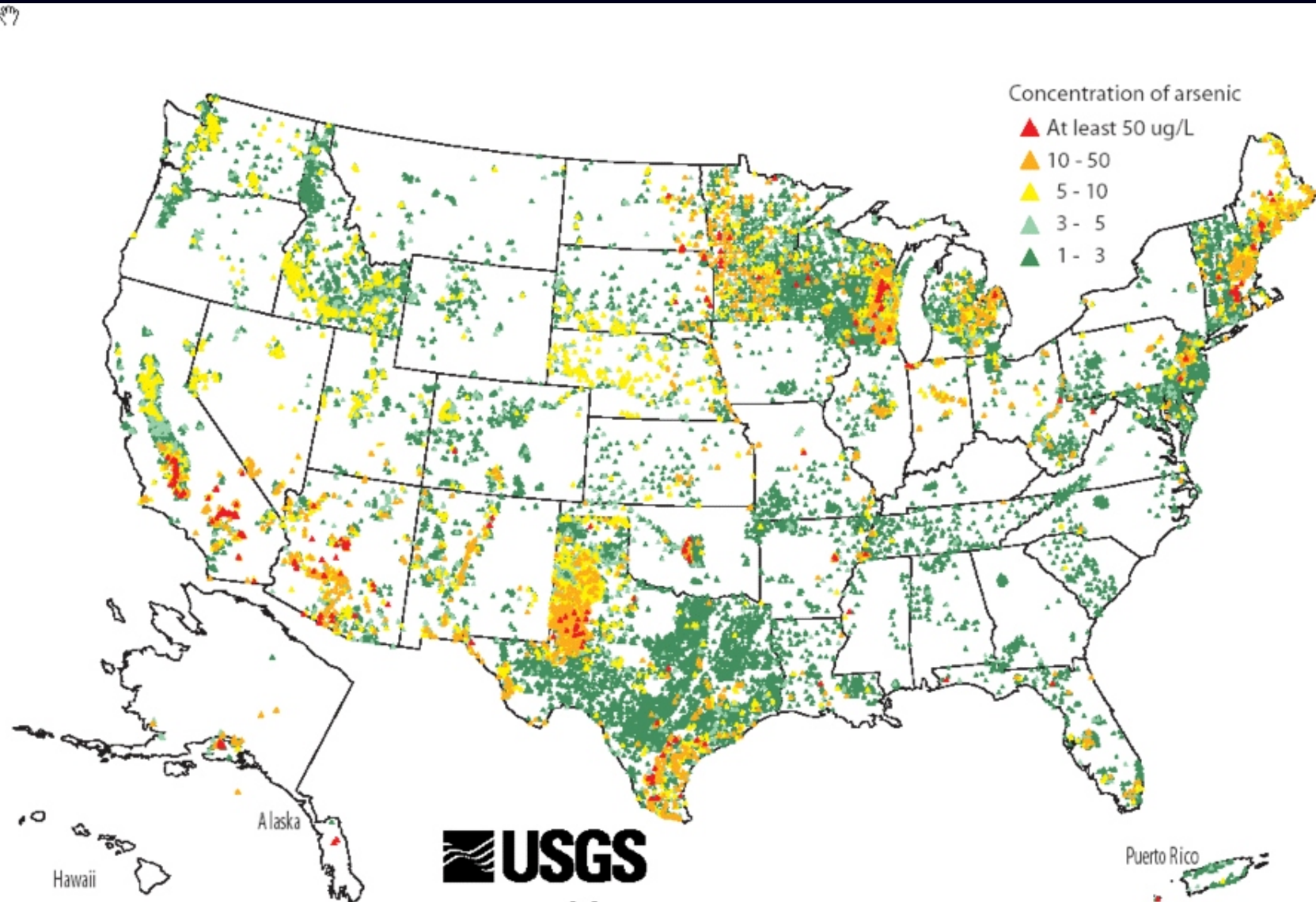


Outline

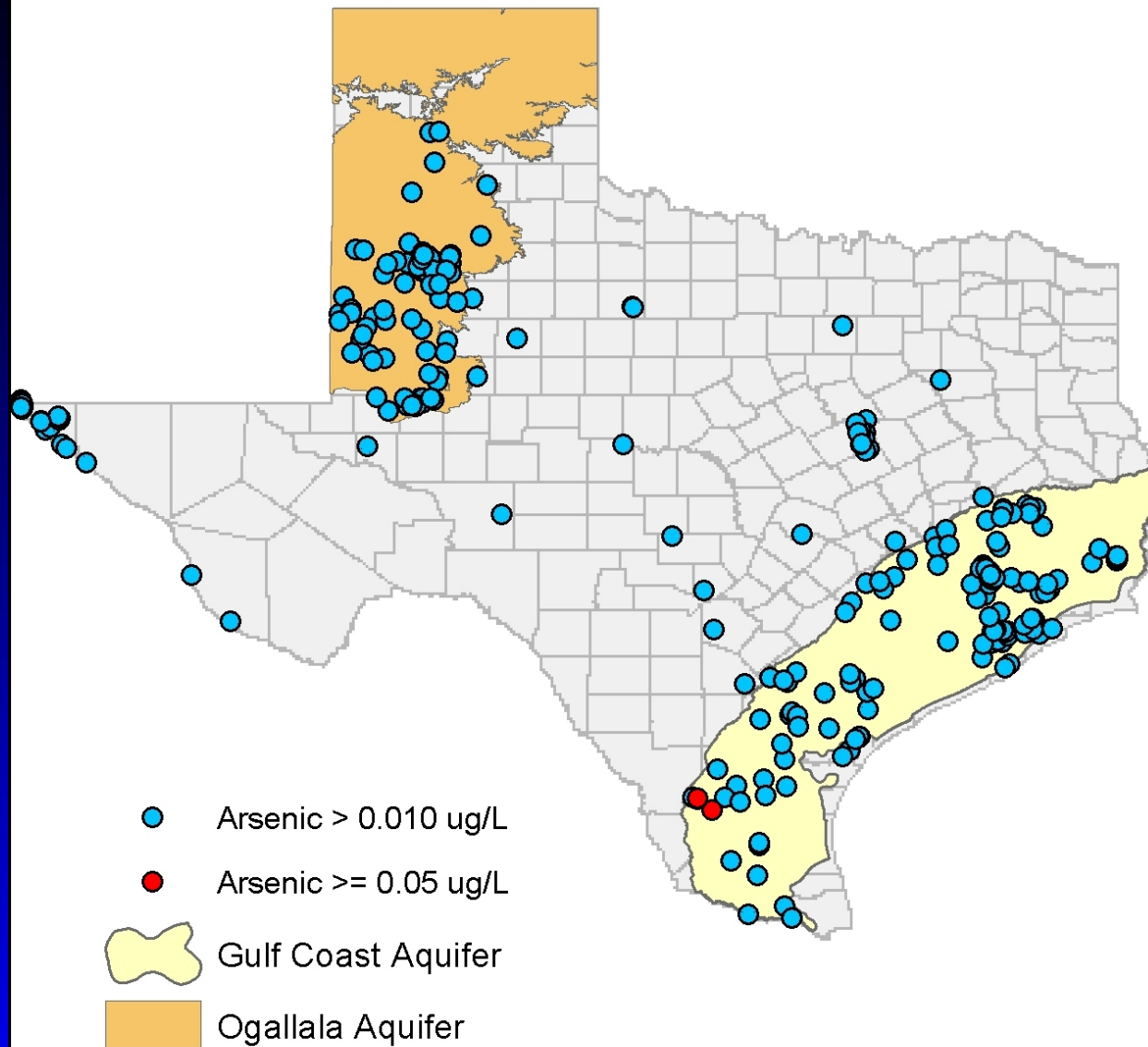
- ▶ Arsenic occurrence in Texas
- ▶ Revised Arsenic Rule
- ▶ Treatment options
 - Competitive technologies



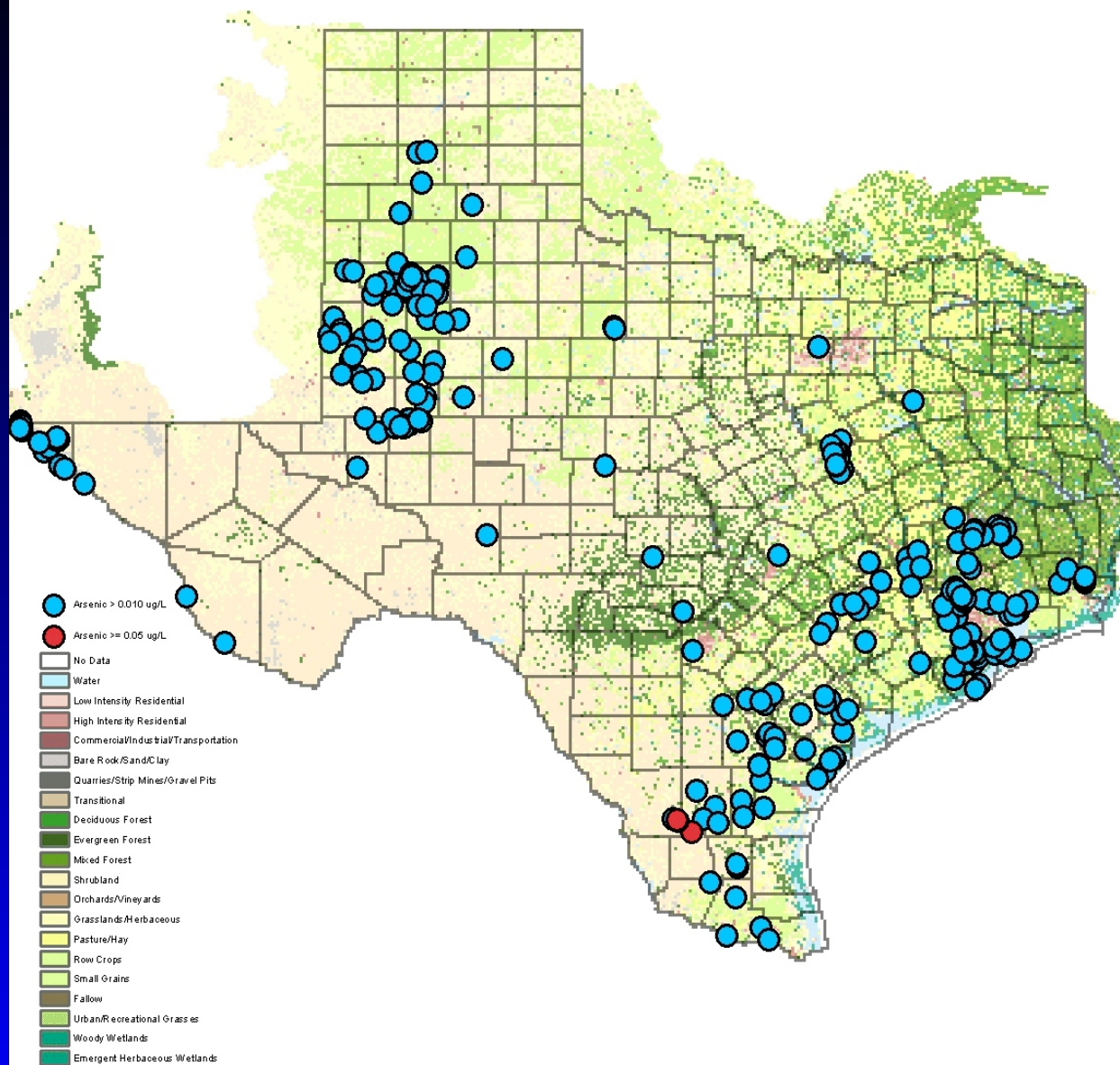
Concentrations of Arsenic - Wells



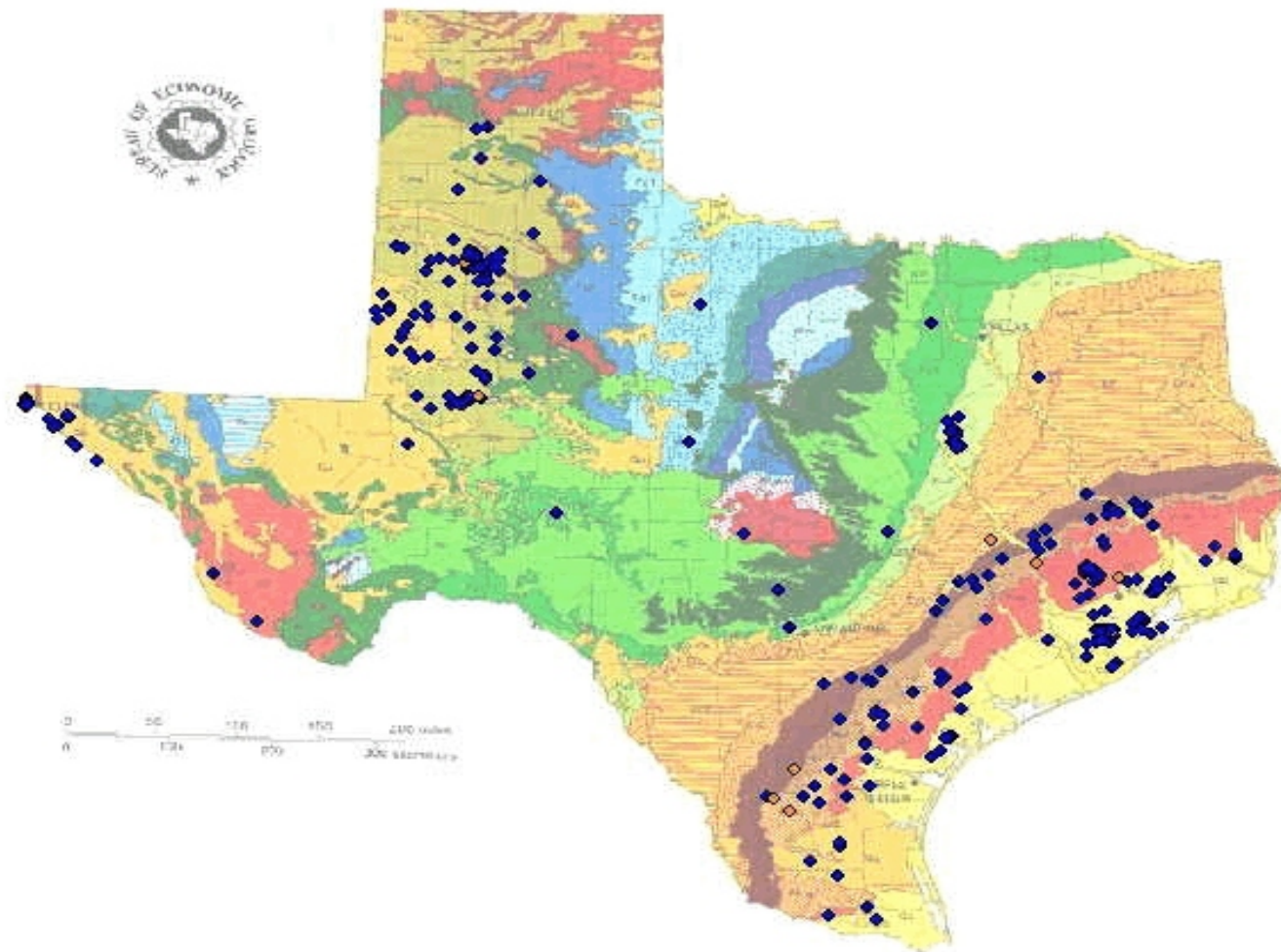
Potential Arsenic Violators



Potential Arsenic Violators



Potential Arsenic Violators



Arsenic Rule

- ▶ Revised Arsenic maximum contaminant level (MCL) takes effect January 23, 2006
- ▶ Arsenic MCL = 0.010 mg/L (10 ppb)
- ▶ Rule applies to all community and non-transient, non-community water systems
- ▶ Systems must sample at each entry point to the distribution system



Treatment

Available Processes

- ▶ Sorption Treatment
- ▶ Membrane Treatment
- ▶ Precipitation / Filtration



Treatment (cont.)

(~ 95% Removal Efficiency)

- ▶ Sorption Treatment Processes
 - Ion exchange (IX)
 - Activated alumina (AA)
 - Iron-based sorbents (IBS)
- ▶ Membrane Treatment Processes
 - Reverse osmosis (RO)



Treatment (cont.)

(Removal efficiency %)

- ▶ Precipitation / Filtration Processes
 - Coagulation-assisted microfiltration (90%)
 - Enhanced coagulation / filtration
 - w/ Alum (< 90%)
 - w/ Ferric chloride (95%)
 - Enhanced Lime Softening (LS) (90%)
 - Oxidation / Filtration - greensand (50-90%)



Competitive Technologies

Pros / Cons

- ▶ Adsorption - simple, non-regenerative in most cases
- ▶ Coagulation / Microfiltration - effective for Fe / Mn waters
- ▶ Reverse Osmosis - effective for TDS removal, less for As (III). Most wasteful, 15-25% water loss



Competitive Technologies (cont.)

Pros / Cons

- ▶ Ion Exchange - good for waters with:
 - High As, pH / low SO_4 , HCO_3
 - Co-removal NO_3 and/or CrO_4
 - Requires regeneration / post-treatment, will not remove As (III)
 - Free chlorine converts As (III) to As (V)



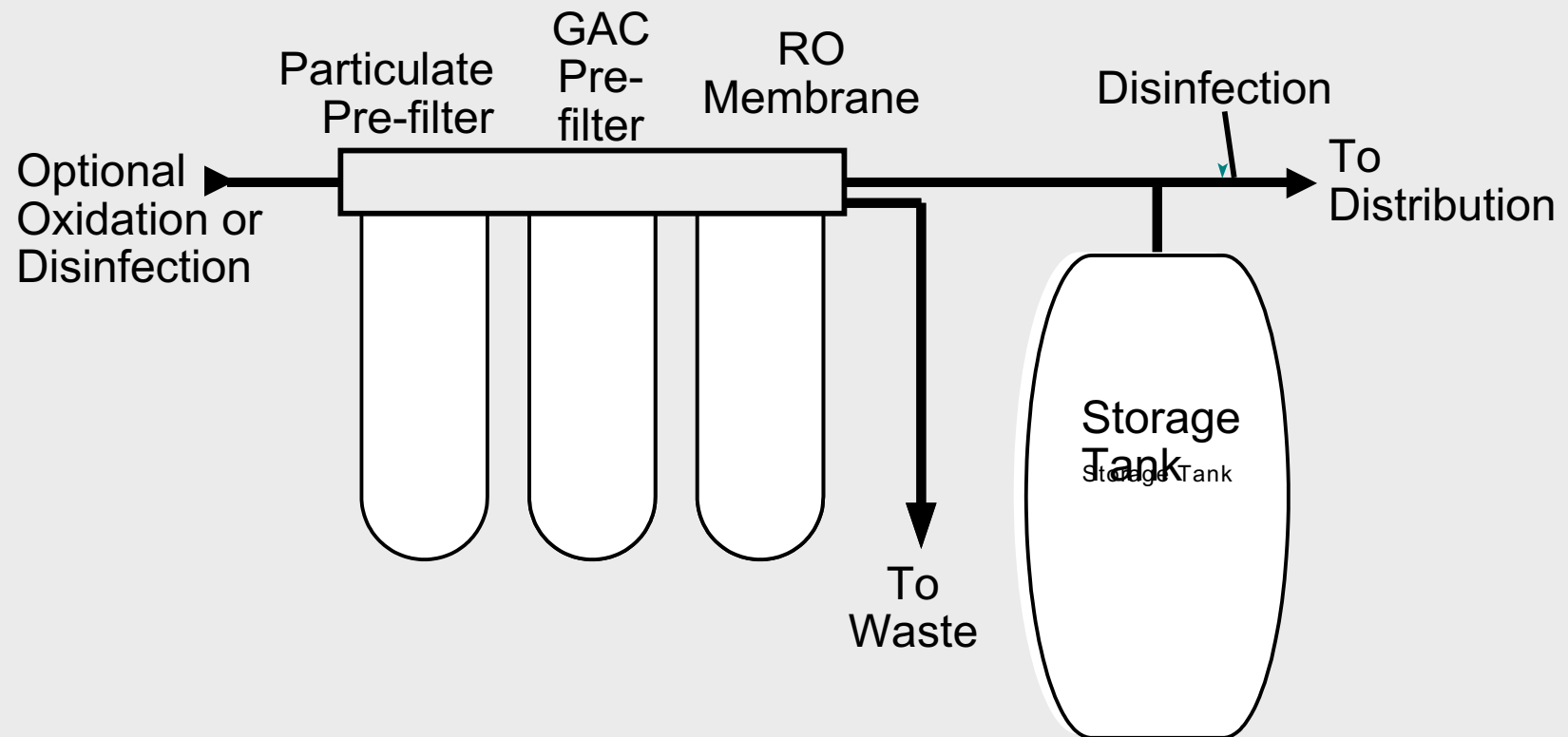
Chemistry Overview

Solubility of Arsenic species

- ▶ As (III)
 - Soluble
- ▶ As (V)
 - Insoluble (only when co-precipitated)



Reverse Osmosis



Feasibility of Treatment

Treatment cost?

- ▶ Factors to consider:
 - Capital required
 - Maintenance
 - Sampling (Arsenic removal effective?)
 - Waste Discharge Permit (fee?)



Feasibility of Treatment (cont.)

- ▶ All costs per connection

Example calculations:

Treatment cost \$40,000 for 1,000 connections = \$40/connection

Treatment cost \$10,000 for 50 connections = \$200/connection

- ▶ Message: Start saving now!



Rate Increase Application

- ▶ If Investor-owned Utility
 - Submit rate increase application
 - Capital improvement surcharge

Title 30 TAC 291.31(d)



Approval as Innovative Treatment through TCEQ Exception Process

Exception request is submitted by the system or its engineer.

Exceptions are granted to the system, not the manufacturer of the treatment unit.

- ▶ Title 30 TAC 290.39(1)



Plans/Specifications Review and Exception Requests

Submit documents to TCEQ Public Drinking Water Section (MC-155)

- ▶ Plans Review Team (plans/specs)
- ▶ Technical Review & Oversight Team (exception request including pilot study report or data from site with similar raw water)



Permitting for Waste Discharge

Submit waste discharge application to TCEQ or
Publicly Owned Treatment Works (POTW)

- ▶ Applicable City Ordinances?
- ▶ Pre-treatment?
- ▶ POTW - each may have different limits and requirements



Waste Discharge Applications

Spent Media Disposal Options

- ▶ Municipal Solid Waste
- ▶ Industrial / Hazardous Waste



Permitting for Waste Discharge

- ▶ Contact TCEQ's Industrial/Hazardous Waste to determine if material is listed as hazwaste



Point-Of-Use Approval

Submittals to TCEQ for approval of POU or Whole-House Treatment (WHT) will contain:

- ▶ Cost comparison (feasibility study)
- ▶ Pilot test results
- ▶ 100% customer participation required
- ▶ Proof of ANSI / NSF approved devices



Point-Of-Use Approval (cont.)

POU or Whole-House Treatment (WHT) must have:

- ▶ TCEQ-approved sampling plan
- ▶ Units owned/maintained by the utility
- ▶ Local ordinances defining liability



Is POU / POE the Best Strategy?

- ▶ POU or POE must clearly be the best compliance choice for the community
- ▶ Financial savings (\$ / household) is primary customer incentive
- ▶ Water system must be committed to making POU / POE work



POU Sampling Plan

- ▶ Ensure every unit is working
- ▶ Rotate sample sites
- ▶ Compliance samples plus field test
- ▶ Approved sampling plan



Summary

- ▶ Sources of Arsenic
- ▶ Treatment options
- ▶ Revised Arsenic MCL
- ▶ Map showing potential violators



Summary (cont.)

- ▶ Submit:
 - Exception request with pilot study
 - Plans and specifications
 - Discharge permit application to TCEQ or POTW
- ▶ Centralized Arsenic removal vs POU or WHT



TCEQ Contacts

- ▶ Land Application of Sludge
(512) 239-3410
- ▶ Industrial Wastewater
(512) 239-4671
- ▶ Municipal Solid Waste
(512) 239-2334
- ▶ Industrial / Hazardous Waste
(512) 239-6412



More Information

Guidance, training, treatment information

- ▶ <http://www.epa.gov/safewater/arsenic.html>
- ▶ <http://www.usgs.gov>
- ▶ <http://www.twdb.state.tx.us>



Questions?



Drinking Water Quality Team

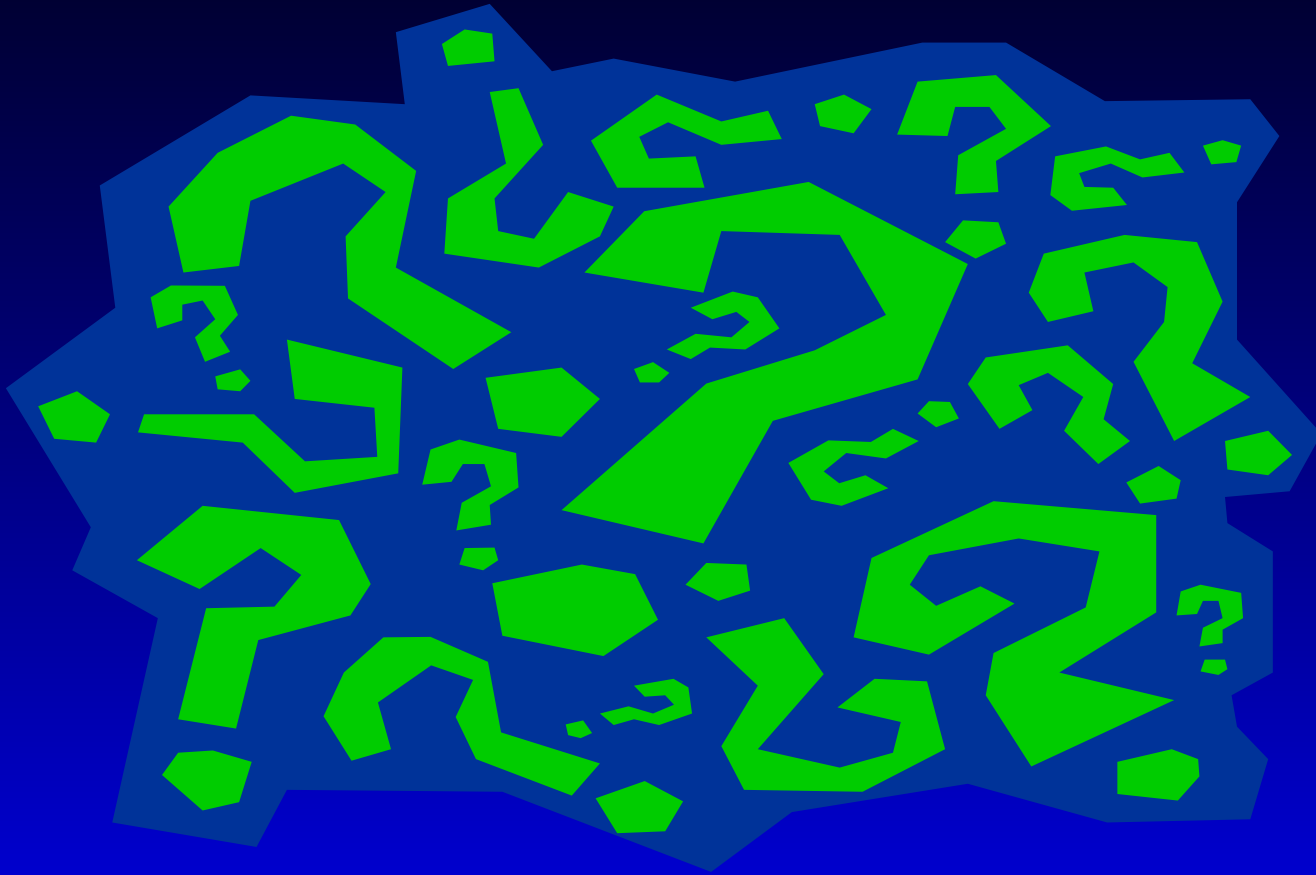
Public Drinking Water Section

(512) 239-4691

<http://www.tceq.state.tx.us>



Questions



Bonus Slides



Sources of Arsenic

- ▶ Naturally-occurring element
- ▶ Agriculture - insecticides, rat poison, herbicides, wood preservative
- ▶ Pigments - paints, ceramics, wallpaper
- ▶ Medicine - treatment of syphilis, leukemia, psoriasis



Arsenic Health Effects

Long-term exposures to high levels ($\gg 0.05$ mg/L) of Arsenic have been linked to:

- ▶ Cancers - bladder, lungs, skin, kidneys, nasal passages, liver, and prostate
- ▶ Cardiovascular, pulmonary, immunological, and neurological effects



Arsenic in Texas

Hueco-Mesilla Bolson

Ogallala Aquifer - Interbedded sand, clay, silt

Gulf Coast Aquifer - Includes the Jasper, Chicot, and Evangeline aquifers. Interbedded clays, sands, silts, and gravels.

- ▶ **Processes** - Arsenic in Ogallala groundwater may be associated with natural uranium mineralization in the High Plains.
- ▶ Arsenic in some areas of Ogallala and Gulf Coast aquifers may be associated with agriculture.



Arsenic Monitoring

- ▶ Groundwater systems will be required to collect samples every 3 years
- ▶ Surface water systems will be required to sample annually
- ▶ If initial sample results $<$ MCL, systems will be eligible for reduced monitoring



Arsenic Monitoring

- ▶ Quarterly sampling must be implemented if the Arsenic concentration in any sample is $> \text{MCL}$
- ▶ Compliance is based on a running annual average (RAA) of the quarterly sample results

Title 30 TAC 290.106(c)(3)(C)



Arsenic Monitoring (cont.)

After initiation of quarterly sampling, TCEQ may allow the system to return to routine Arsenic monitoring IF...

Quarterly sampling results are reliably and consistently $< \text{MCL}$.

Title 30 TAC 290.106(c)(3)(C)



Public Notice

Mandatory Language

- ▶ TCEQ notifies the system that drinking water supplied to their customers exceeds the Arsenic MCL
- ▶ EPA has established Arsenic MCL (0.010 mg/L) and determined that concentrations above this level are a health concern
- ▶ This situation is not an emergency



Public Notice (cont.)

- ▶ However, some people who drink water containing Arsenic in excess of the MCL over many years could experience skin damage, problems with their circulatory system, and/or may have an increased risk of getting cancer.
- ▶ For further information, contact the water system.



Certificate of Delivery of Public Notice

System must certify delivery

- ▶ Date notice was delivered to customers
- ▶ Reporting period (i.e., Quarter 1 2005)
- ▶ Signed / dated by system representative

